



**ELECTRONIC
SYSTEMS
DIVISION**

GENERAL ELECTRIC COMPANY, ELECTRONICS PARK, SYRACUSE, NEW YORK 13201
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OPTOELECTRONIC SYSTEMS
OPERATION

TN2200 SERIES
AUTOMATION CAMERA
SPECIFICATIONS/APPLICATIONS

Here is your copy of the latest information on our newest product line. Featuring our patented CID Microsensor, the TN2200 Series is designed to be the EYES OF A NEW GENERATION OF SMART MACHINES.

When interfaced to a data processor or computing system, these cameras provide information to measure, inspect and sort a wide range of objects such as moulded plastic parts, punch press dies, pills, IC chips, produce and containers.

Consider how this new capability can be applied to improve your productivity and product quality.

Please review this information carefully. We will be happy to answer your questions and discuss your application.

SEND YOUR ORDER TO:

GENERAL ELECTRIC COMPANY
OPTOELECTRONIC SYSTEMS OPERATION
BUILDING #3-201, ELECTRONICS PARK
SYRACUSE, NEW YORK 13201

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RT:mrc
Enclosures

AN EQUAL OPPORTUNITY EMPLOYER



TN2200

TN2201

SOLID-STATE AUTOMATION CAMERA



OPTOELECTRONIC SYSTEMS OPERATION
EP3-201, SYRACUSE, NEW YORK 13201
(315) 456-2832 or 2808

GENERAL  **ELECTRIC**

TN2200

TN2201

General Electric unveils its latest development in solid state imaging, the TN2200 Series Automation Cameras, featuring a patented CID Microsensor, compact rugged design, variable scan rate, and square pixel spacing. Coupled to microprocessor or minicomputer controlled signal processing and controlled lighting, these cameras can provide visual inputs to control quality of small parts, monitor machine operations, sort produce, guide robot arms, gather scientific data, and a host of other applications.

HIGHLIGHTS

100% Solid State Reliability
Small Size
Low Power Consumption
Precise Spatial Geometry
Variable Pixel Data Rate to 700 kHz
Flexible Interfacing
No Image Burn and/or Lag
Drift Free Scanning
Integrating Detectors

CAMERA OPERATION

The TN2200 Microsensor contains an array of 128x128 (16,384) pixels and the TN2201 has an array of 42x342 (14,364) pixels. Electronics in the camera body perform analog signal derivation functions.

The TN2200 series can view almost any object by careful selection of lens and viewing distance. The TN2200 is used to observe relatively square objects while the TN2201 array lends itself to observing linear objects. Objects as diverse as semiconductor chips, bottle caps, holes, medical samples, lines of characters, instrument scales, ball point pens and sewing needles can be viewed.

TECHNICAL SPECIFICATIONS

Electrical

Power Source $\pm$ 15V at 50 ma

Mechanical

Weight: Fixed Head Cameras	18 oz (510 gr)
Remotable Head Cameras	21 oz (596 gr)
Remote Head Only	8 oz (227 gr)
Remote Body Only	13 oz (369 gr)

Lens Mount: Standard "C" Mount
1 inch (25.4 mm) 32 Thread

Camera Mount: 1/4 x 20 Tapped Hole

Connector: Amphenol 67-03-E-14-12-P

Case: Dust Tight Aluminum Extrusion

Environmental

Ambient Temperature: 0° to 50°C (32° to 123°F)
Altitude: 50,000 ft (15,240 m)

Signal-to-Noise Ratio

Temporal SNR	256:1 typical
Spatial SNR	15:1 typical

BLEMISH SPECIFICATION

Maximum 8 black or white pixels at 30 frames/second 25°C (77°F) ambient.

LENS SELECTION

Lens selection for the TN2200 is a function of matching the scene observed to the active area of the microsensor. Pixels are located on 0.0018 inch centers and generally may be considered contiguous. Thus, the image size is $128 \times 0.0018 = 0.2304$ inch per side. Applying the normal lens formula,

$$\frac{\text{Object Size (OS)}}{\text{Object Distance (OD)}} = \frac{\text{Image Size (IS)}}{\text{Focal Length (FL)}}$$

will yield the proper lens selection.

The TN2200 is designed to accept C-mount lenses which have a fixed back mounting flange length of 0.69 inch. The viewing angle can be selected by choosing standard lenses. The following chart lists the ratio of distance from an object to the size of an object for available lenses.

TN2200 (128 x 128 ARRAY)

Focal Length		Object Size/Object Distance
mm	Inches	
4.5	0.18	1.3
6.5	0.26	0.89
9	0.35	0.65
12.5	0.50	0.46
16	0.63	0.37
17	0.67	0.34
25	1.0	0.23
35	1.4	0.17
50	2.0	0.12
75	3.0	0.08
100	4.0	0.06

For example, to view a 6-inch object at a 4-foot distance, the object size/distance ratio is $0.5/4 = 0.125$. Therefore, a 50 mm lens is appropriate for this application.

The TN2201 requires 1-inch vidicon C-mount lenses because of the length of the image plane. The array is organized as 342 rows of 42 pixels. The pixels are on 0.0016 inch centers and thus the image size is $0.0016 \times 342 = 0.5$ inch high and $0.0016 \times 42 = 0.067$ inch wide. Applying the lens formula yields the following size to distance ratios.

TN2201 (42 X 342 Array)

Focal Length		Object Height/ Object Distance	Object Width/ Object Distance
mm	inches		
6.5	.26	2.1	.25
12.5	.50	1.1	.12
25	1.0	.54	.064
50	2.0	.27	.032
75	3.0	.18	.021

For example, if a 1-foot 1-inch wrench were to be observed from a distance of 2 feet, the height/distance ratio would be $1.08/2 = 0.54$. Therefore, a 25 mm lens would be appropriate. The camera would see $0.064 \times 2 = 0.128$ foot or about 1.5 inches horizontally.

TN2200/TN2201 ELECTRICAL CONNECTIONS

INPUTS

+15V dc	Positive Power Supply - draws less than 50 ma.
Power Return	Power Supply Ground Line
-15V dc	Negative Power Supply - draws less than 50 ma.
II	Inject Inhibit Mode Control - Camera operates normally when not connected or connected to power ground. When connected to +15V dc, it places camera into a controllable light integrating mode; otherwise light integration time is equivalent to frame time.
LRR	Line Re-Read Mode Control-Camera operates normally when not connected or connected to power ground. When connected to +15V dc, it causes each line to be read twice in succession. The first reading contains signal plus spatial noise information; the second read contains the spatial noise information only. This applies to the TN2200 only.
Clock	Input terminated for high frequency operation. Drive at 10 times desired pixel rate with 0 to 5V, 50% duty cycle signal.
Clock Return	Direct return path for clock input.

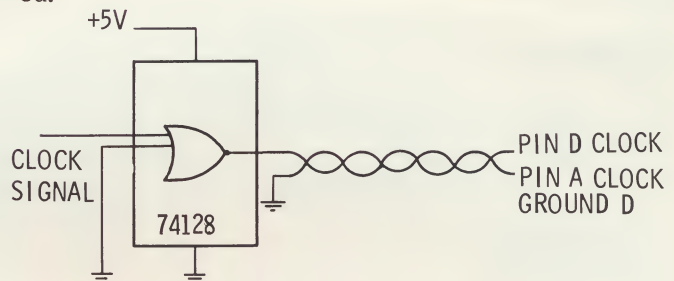
OUTPUTS

Video	Provides sampled video information. Approximately 0V for black and 1V for white.
Video Return	Reference point for video. Power return and clock return potential.
Strobe	Strobe CMOS 4049 Output - Goes low when new video sample is presented.
$\overline{\text{EOL}}$	End of Line CMOS 4049 Output - Goes negative when the last element in a line is selected. Sampled video of last pixel is presented approximately one pixel time into $\overline{\text{EOL}}$ period. Low state is held during full 6-pixel retrace period.
$\overline{\text{EOF}}$	End of Frame CMOS 4049 Output - Similar to $\overline{\text{EOL}}$ except referenced to 4-line vertical retrace period.

TTL INTERFACE

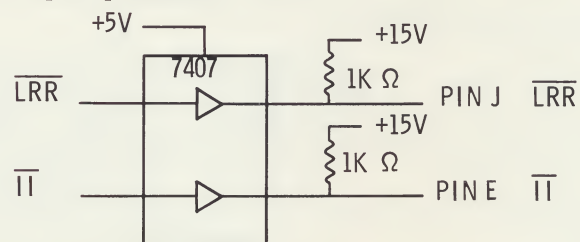
CLOCK INPUT

The TN2200 is designed to accept a TTL LEVEL CLOCK SIGNAL. If long cables (over 10') are to be driven, a line driver such as an SN74128 is recommended.



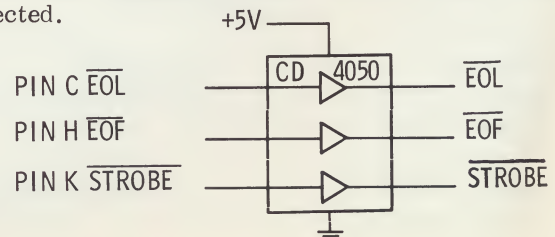
LINE RE-READ AND INJECT INHIBIT INPUT

The TN2200 has a CD4049B hex inverter buffer to accept this signal. To drive it from TTL, an open collector output such as an SN7407 could be used with a 1 K Ω pullup resistor.



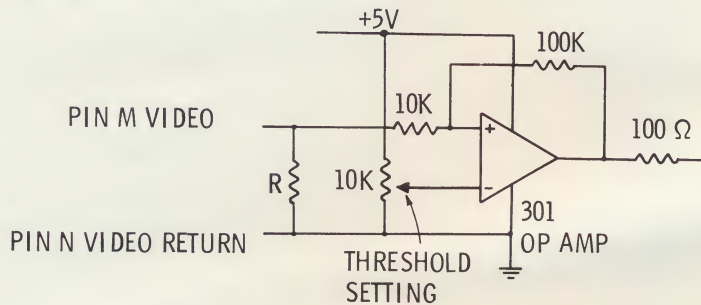
STROBE, $\overline{\text{EOL}}$, AND $\overline{\text{EOF}}$ OUTPUTS

These are CD4049B CMOS outputs. By using a CD4050 buffer biased at 5 volts, a TTL conversion can be effected.



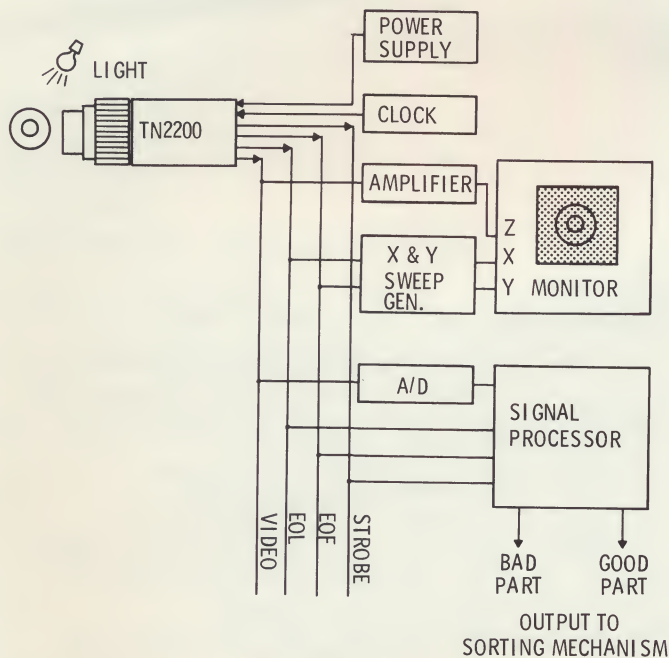
VIDEO OUTPUT

The video signal may be converted to TTL levels in a variety of ways depending on the amount of gray scale required. The simplest conversion is to a thresholded or binary (black/white) output. Choose R to match the impedance of the video cable.



TYPICAL VIDEO INSPECTION SYSTEM

A typical video inspection system is shown in the schematic. A part to be inspected is illuminated to enhance the features to be observed and the camera is positioned to see those features. A lens is selected to cover the area to be observed.

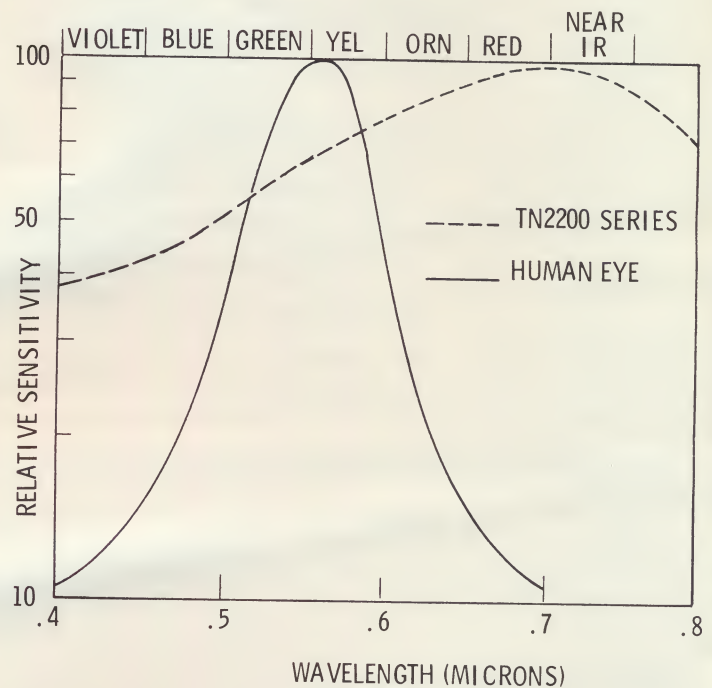


The speed of the scan is chosen to match the signal processor requirements and is controlled by setting the clock frequency.

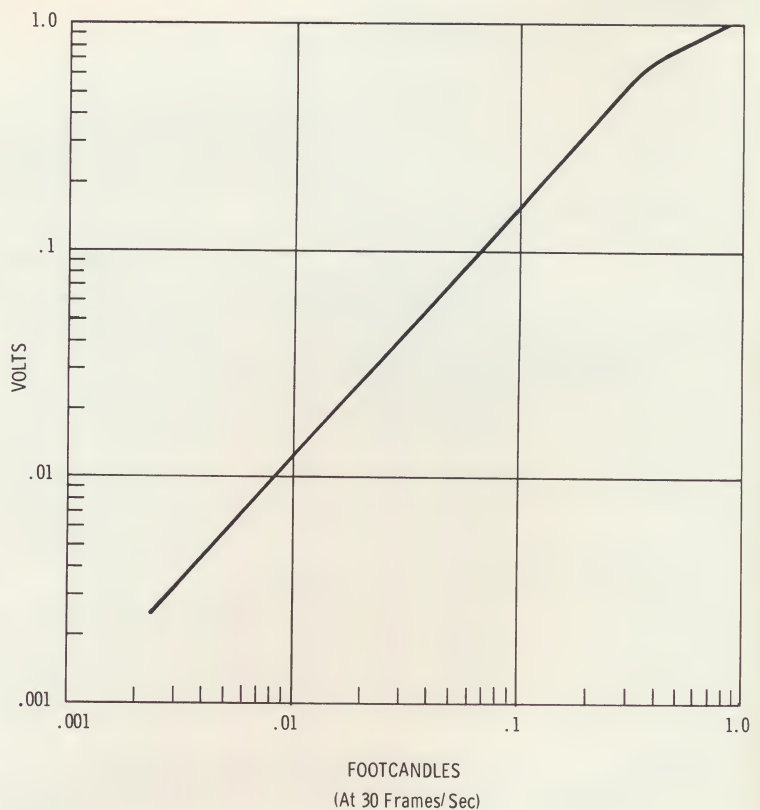
The decision as to whether or not the part is good or bad is made by a signal processor which may be a mini- or micro-computer-based system. An analog to digital conversion will be required for the video signal if it is to be processed digitally.

In many systems a monitor view of the object is useful. A view may be presented by amplifying the video to modulate the Z axis of an X-Y monitor or

oscilloscope, and by providing vertical (Y) and horizontal (X) sweep signals synchronized to the video with the EOF and EOL signals.

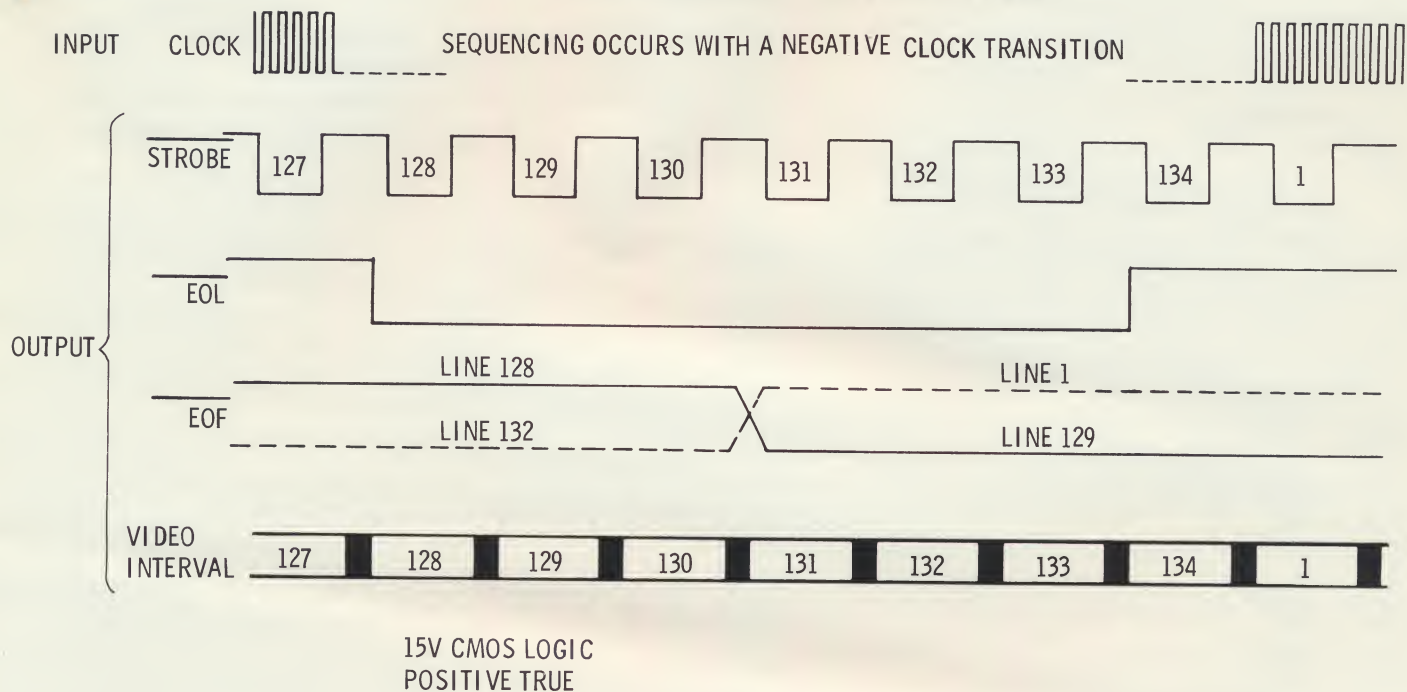


TN2200 Series Relative Spectral Response



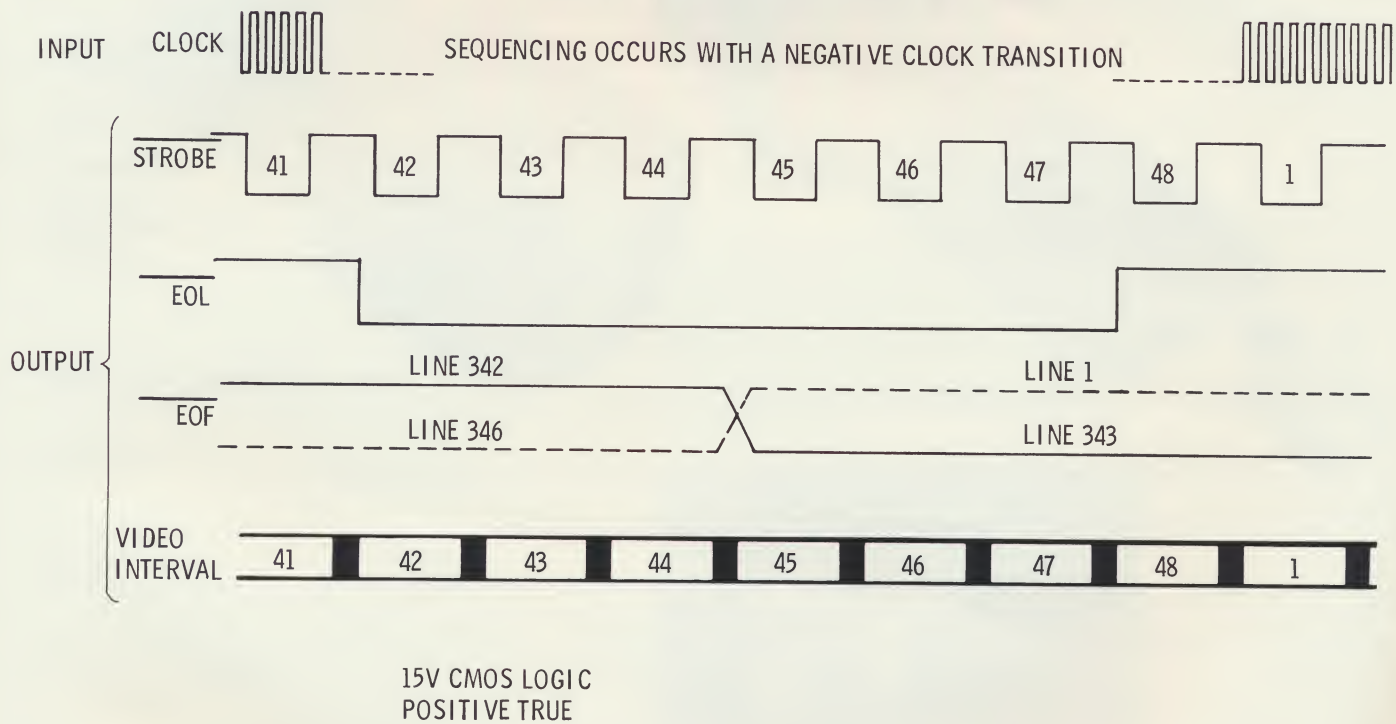
Typical Output Voltage Vs. Pixel Illumination

CLOCK IS VARIABLE FROM 50 KHZ TO 7 MHZ

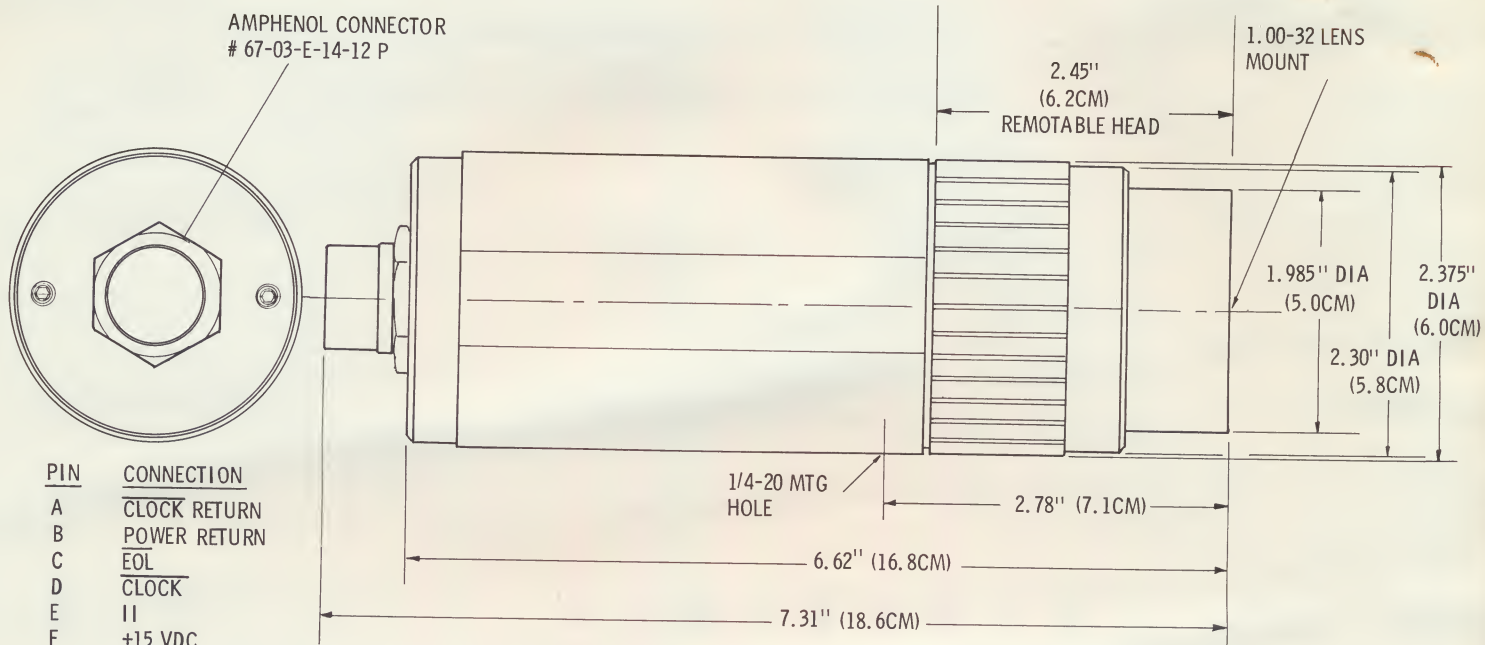


TN2200 Timing

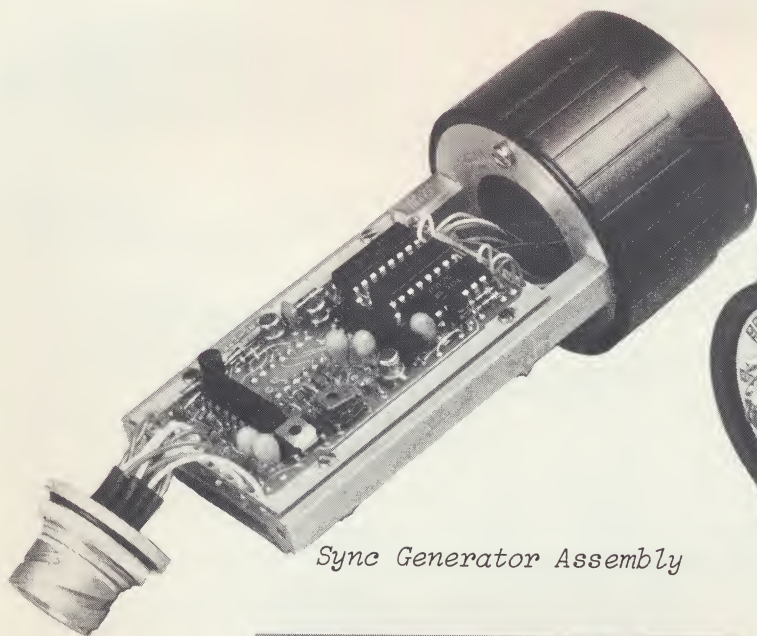
CLOCK IS VARIABLE FROM 50 KHZ TO 3.5 MHZ



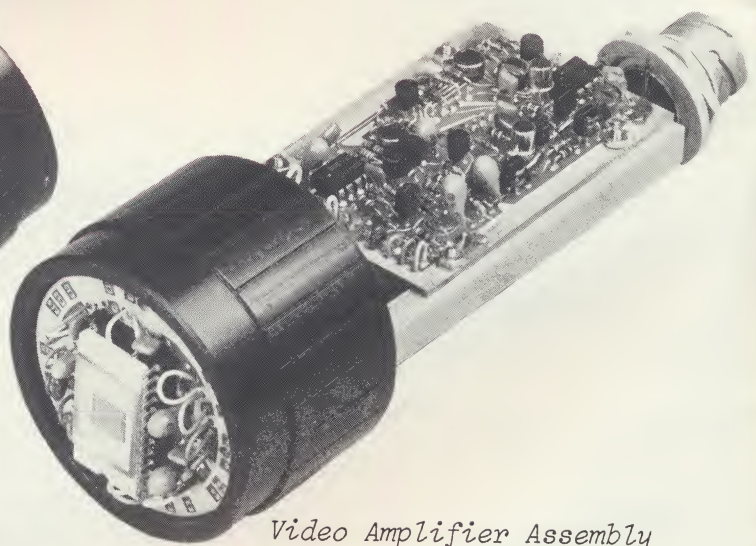
TN2201 Timing



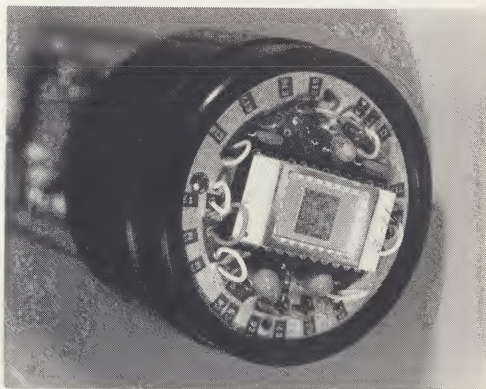
TN2200 Side View



Sync Generator Assembly



Video Amplifier Assembly



Sensor Assembly

QUESTIONS AND ANSWERS

- Q What do I need to make these cameras operate?
- A The TN2200 series cameras require a C-mount lens, cable, power supply and clock for operation.
- Q How can I make a picture with the TN2200 series?
- A The simplest method of observing the output is to use an X-Y monitor or oscilloscope with Z-axis modulation. Use two ramp generators and reset them with the EOL and EOF camera outputs to sweep the screen in synchronization with the camera scan. By modulating the Z axis with the video signal, a TV-like picture is generated. This interface is provided by the amplifier and X-Y sweep generation modules.
- Q Can I use a standard TV monitor?
- A Not without constructing a fairly elaborate scan converter to produce a high speed TV style picture.
- Q How sensitive is the TN2200 series?
- A Because the pixels collect signal charge over a full frame time, normal room lighting levels are usually sufficient for operation. In order to simplify the signal processing, the scene to be viewed should be arranged to have high contrast.
- Q How do I plug the TN2200 series into a computer?
- A The TN2200 offers a wide degree of flexibility for computer interface. The analog output can be converted using standard A/D procedures. The variable data rate facilitates matching to the conversion and I/O rates of available computers.
- Q Can I measure an object to two thousandths of an inch?
- A Yes! The camera divides what it sees among the 128 x 128 or 42 x 342 pixels. If a TN2201 sees a 0.3-inch-diameter object along 300 of its 342 pixels, then each pixel sees one thousandth of an inch.
- Q How fast can this camera inspect objects?
- A By synchronizing the camera to the positioning of the object and assuming adequate signal processing, production rates well over 1,000 per minute are possible.

GLOSSARY

- C-Mount Lens** An industry standard for lens mounting. Has 1-inch-diameter threaded barrel with 32 threads per inch.
- Frame Time** That time required to scan a full array including blanking time. TN2200 frame time equals 17,688 pixel times. TN2201 frame time equals 16,608 pixel times.
- Line Time** That time required to scan a single line of pixels including blanking time. TN2200 line time equals 134 pixel times. TN2201 line time equals 48 pixel times.
- Pixel** Contraction for picture element or light sensitive point. The TN2200 has 16,384 pixels and the TN2201 has 14,364.
- Pixel Time** That time required to scan a single pixel. Pixel time is 10 clock periods and user determined.
- X, Y, Z Axes** Refers to oscilloscope inputs, X axis is left/right, Y axis is up/down, Z axis is bright/dim.

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